SUMMARY AND FINAL REPORT ON REVEGETATION OF OVERBURDEN DEPOSITS AT THE COMSTOCK MINE, CEDAR CITY, UTAH

Submitted by

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During the past five years, research has been conducted by members of the faculty of Southern Utah State College at the Comstock Mine west of Cedar City, Utah. Progress reports have been submitted detailing methods used. This report will summarize the important aspects of the projects and recommendations based on the findings of the research team.

LAND MANAGEMENT

Because of the nature of the dumps, it is very important that this subject be addressed at the onset of this report. The dumps in their present unmodified condition present an almost impossible situation for the propagation of plants from seeds. Nine plant species were tested on these unmodified slopes. Replications were made in both fine and rocky tailings. After 3 years and several plantings the only plant to show germination and growth was bitterbrush (Purshia tridentata). Five small plants had managed to germinate and grow. The five seedlings were not within the plots where the seeds were originally planted, but in plots below. This seems to support the observation that the tailings are in almost constant motion because of their acute angle.

SLOPE MODIFICATION

The results of previous trials indicate that revegetation of mine dump slopes by seeding would be futile without slope modification to stop constant movement of the tailings. It is our recommendation that these slopes be modified as they were in the most recent investigations (Photo #1). The modification of the slope in this way has dramatically increased the germination, growth and survival of the majority of the plants tested (see Tables I, II).

EVALUATION AND RECOMMENDATIONS

PLANT SPECIES

A. Plugs

Over the test period, six species of shrubs have been planted as seedlings, both on modified and unmodified slopes. The following is a summary of each by species:

1. Four-winged salt bush (Atriplex canescens) Not recommended

   Four-winged salt bush, although it shows a 54% survival rate (Table I) after 2 years as plugs on the modified slopes, has a growth rate which is very slow. It shows little immediate promise on the modified slopes.

2. Serviceberry (Amelanchier utahensis) Not recommended

   The survival rate of Serviceberry was 38% (Table I). Growth is slow (see Photo #17). Results may have been influenced some by the condition of the plugs at the planting time.

3. Fernbush (Chamaebatiaria millefolium) Recommended

   Fernbush was the most successful of all plugs. One hundred percent (Table I) of the plants survived and are growing vigorously (see Photos #11, 12). This plant grows to be a fairly large shrub and survives in very harsh conditions. It is our recommendation that fernbush be used selectively in areas that would be hard to contour or that it be planted randomly throughout the seeding area.

4. Squawbush (Rhus trilobata) Recommended

   This shrub has a very good survival rate of 71% (Table I) and like fernbush grows to be a large, conspicuous shrub

(see Photo #10). It could be planted on most areas of the modified slopes.

5. Rabbitbrush (Chrysothamnus nauseosus) Not recommended as plugs

Rabbitbrush has a very good survival rate of 96%. It grows rapidly into a low (2-4 ft.) shrub. It is felt that to plant rabbitbrush by plugs would be inappropriate use of time and money because of its tendency to establish itself by natural seeding from plants in the area (see Photos #18, 19).

6. Bitterbrush (Purshia tridentata)

Bitterbrush, although it had a survival rate of only 33% (possibly influenced by the dry condition of the plugs when planted), should be considered for planting as plugs because of its fast growth (see Photo #9) and desirability as a browse species. Although we also recommend planting by seed, planting bitterbrush by plugs would speed the revegetation of the dump sites and would give an accelerated visual impact on the area.

B. Seeding

None of the grasses grew on the unmodified slopes regardless of planting method, broadcast or hydromulch. Modification of the dump slope has given some encouraging results, especially with the grasses. Data collected in the fall of 1981 is recorded in Table II. Photos #14, 15, and 16 show these grasses as they appeared the last of May, 1982. The Siberian wheatgrass has seed heads. All grasses have grown in size since the data was collected last fall. Winter survival of all plants was excellent.

The only shrubby species which showed germination were rabbitbrush, antelope bitterbrush, and four-wing salt bush (see Table II). With prevalent invasion onto the test area by rabbitbrush (see Photo #18) it was difficult to determine which rabbitbrush plants were the result of our seeding efforts, but we counted all those within the plot area.

Antelope bitterbrush results were meager but encouraging (Table II). The data shown in Table II should not be taken as the final result. As a rule, germination of the bitterbrush seed may be staggered over a long period of time. Photo #13 shows a young seedling as it appeared this spring.

Four-wing salt bush showed a germination rate on the modified dump slope similar to that recorded for plots on the dump top test area, both quite low.

Fernbush and squawbush showed no germination. Of the shrubs tried, rabbitbrush and antelope bitterbrush are the most promising when planted from seed. With the natural seeding presently taking place and the source of abundant seed in the area, it would be redundant to plant rabbitbrush. Antelope bitterbrush, on the other hand, is an excellent browse plant, and has shown results sufficient to recommend its use. Cliffrose, planted in the original study, has shown some germination since the original data were collected.

MINE DUMP TOPS

Reclamation of mine dump tops can be speeded up by scarifying these compacted areas. Natural invasion by rabbitbrush is more prevalent, and

germination of grass seeds is favored by this practice. The grasses, which were broadcast on the plots, grew in rather definite rows (see Photo #6). This can only be explained on the basis of a more favorable habitat for germination in the furrows created by scarification.

NATURAL REVEGETATION

Natural revegetation is occurring on the mine dumps. Herbs, shrubs, and trees can be seen on all but the most recent dumps. The herbs most frequently observed include Palmers penstemon (Penstemon palmeri), Blazing star (Mentzelia sp.) and Douglas chaenactis (Chaenactis douglasii). The prevalent shrub is rabbitbrush (Chrysothamnus nauseosus). It has become established in dense stands on the mine dump tops and can be seen on the steepest slopes. Recent observations would indicate that invasion by rabbitbrush is enhanced on the modified slope (see Photo #18). Young juniper (Juniperus osteosperma) and pinyon trees (Pinus edulis) occur on some of the older dumps.

SUMMARY

Assuming that the next step in the revegetation of the Comstock mine dumps will be a push to revegetate all or part of the dumps, we recommend the following:

1. Alter the dump slopes to reduce the movement of the tailings at least to the extent of the most recent vegetation trials (Phase IV; see Photo #1). Terracing or some other procedure may be necessary on the very large, most recent dump. During this slope modification phase, attempts should be made to cover rock-strewn areas with finer materials, thus facilitating revegetation efforts.

Scarification of the more recent dump tops, as seen in photos #20, to loosen the severly compacted overburden materials will provide a minimal seedbed and, as has been shown, enhance grass and shrub establishment and growth.

2. Broadcast dump slopes and tops with a mixture of grass and shrub seeds. All grasses (Tegmar intermediate wheat (Agropyron intermedium), Siberian wheatgrass (Agropyron sibericum), and Russian wild rye (Elymus junceus)) have shown good results and are recommended. The shrub species antelope bitterbrush (Purshia tridentata) is strongly recommended. It may be slow to germinate, but it has shown fair to excellent results under all test conditions (see Photos #2, 3, 4, 5, 9 , & 13). Other shrub species that showed fair results when planted from seed are four-wing salt bush (Atriplex canescens) and cliffrose (Cowania mexicana). These could be added to the seed mixture, but are not recommended as highly as is bitterbrush. These shrub species will supplement the everpresent rabbitbrush (Chrysothamnus nauseosus) which is so prevalent in the area (see Photos #8, 18, 19).
3. Selectively plant seedling plugs of antelope bitterbrush, fernbush (Chamaebatiaria millefolium), and squawbush (Rhus trilobata) in areas hard to modify slopewise or the more rocky areas. Seedling plugs could also be used as needed to enhance visual impact and speed revegetation efforts.

Table I. Fall survival data on shrubs planted as seedling plugs.

Plant Species	# Planted		# Surviving		Total Surviving	Percent Survival
	Plot 1	Plot 2	Plot 1	Plot 2		
Rabbitbrush	12	12	11	12	23	96
Serviceberry	12	12	7	2	9	38
Salt bush	12	12	7	6	13	54
Fernbush	12	12	12	12	24	100
Squawbush	12	12	9	8	17	71
Antelope Bitterbrush	12	12	4	4	8	33
Totals	72	72	50	44	94	65

Table II. Fall survival and germination data on grasses, clover and shrubs.

Plant Species	Seeding Rate (lbs./acre)	Total Plants (Sum of 2 plots)	Plant Density (Plants/sq. ft. Plot 1	Plot 2	Average
Grasses					
Tegmar Intermediate Wheatgrass	20 lbs./acre	1232.2	5.4	4.7	5.05
Siberian Wheatgrass	16 lbs./acre	866.2	2.7	4.4	3.55
Russian Wild Rye	20 lbs./acre	671.0	3.7	1.8	2.75
Clover					
Yellow Sweet Clover	8 lbs./acre	8			
Shrubs					
White Stem Rubber Rabbitbrush	4 lbs./acre	27			
Four-wing Salt bush	10 lbs./acre	3			
Antelope Bitterbrush	12 lbs./acre	7			
Squawbush	12 lbs./acre	0			
Fernbush	8 lbs./acre	0			

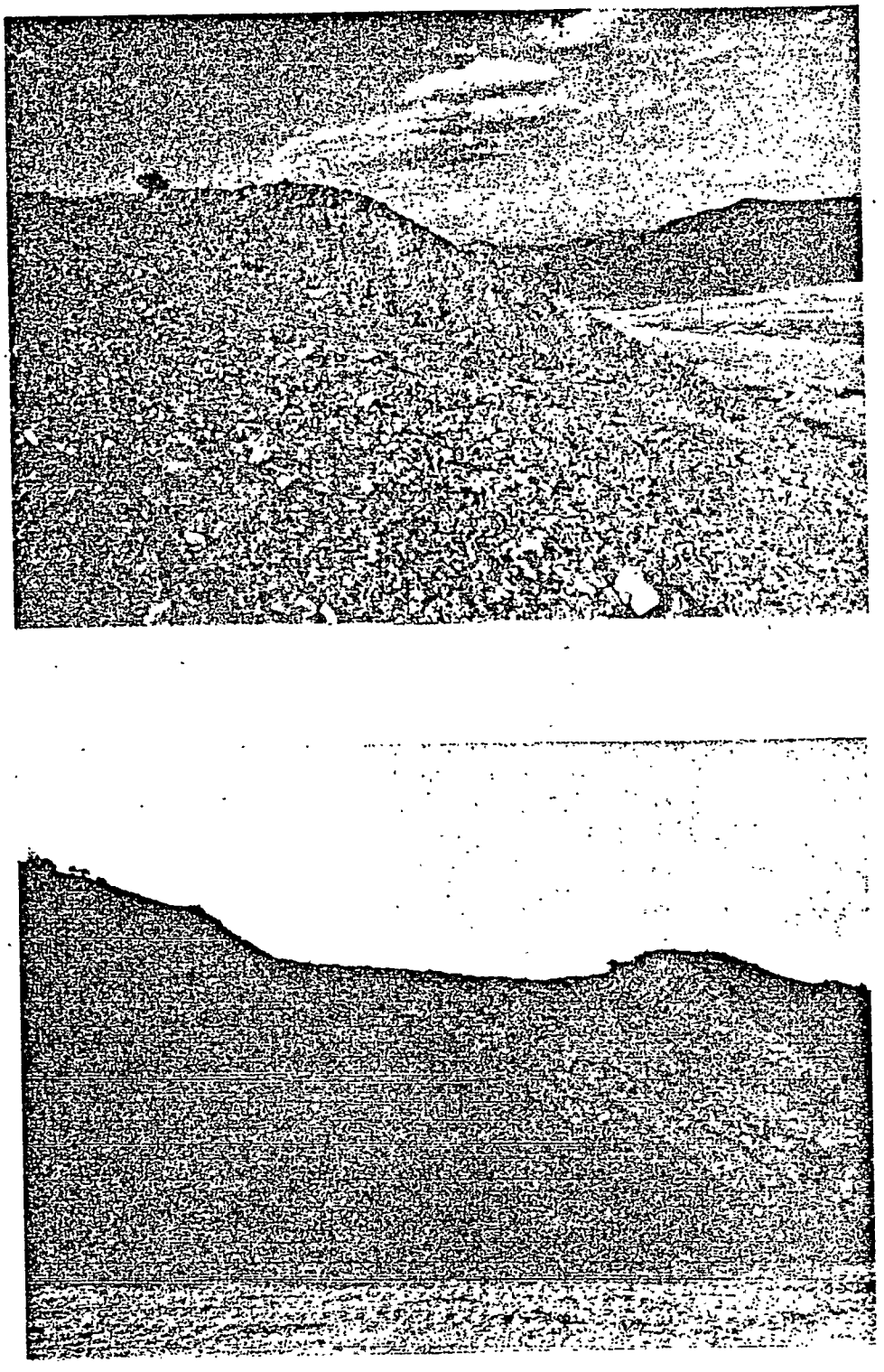


Photo #1. Photos showing the manner and extent of slope modification. Test area is on the upper 2/3 of this slope.

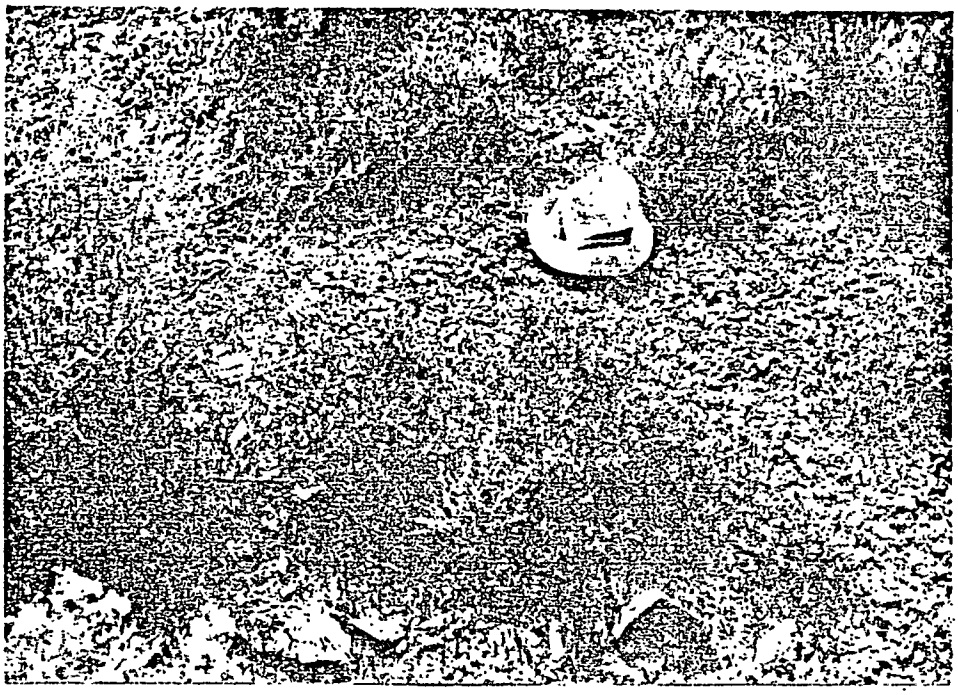


Photo #2. Antelope bitterbrush on original plots. Note size variations.

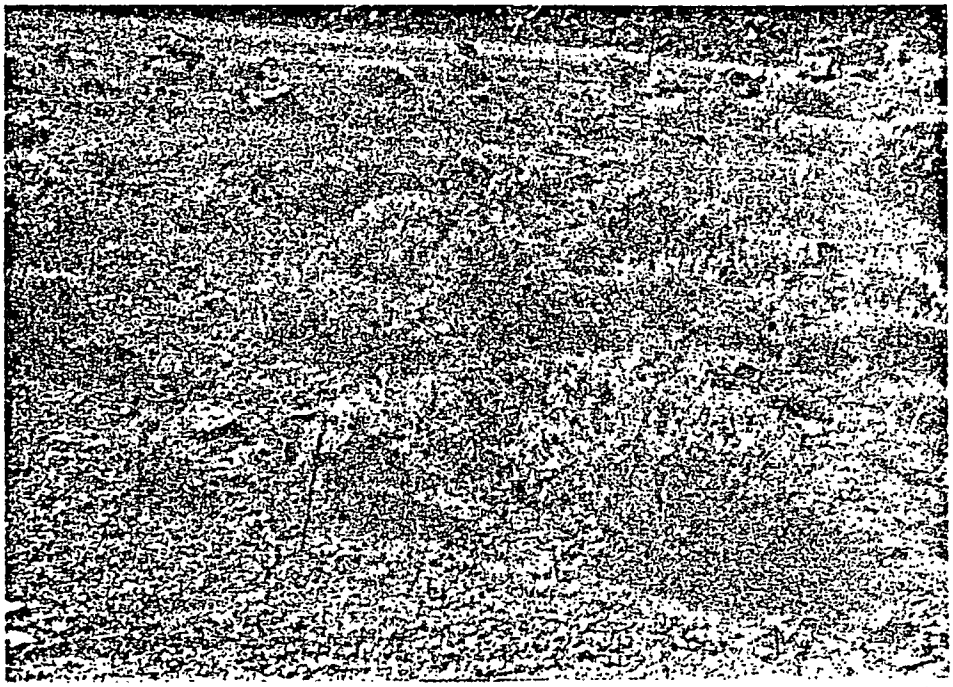


Photo #3. Overview of antelope bitterbrush plot showing bitterbrush plants interspersed with invading rabbitbrush plants.

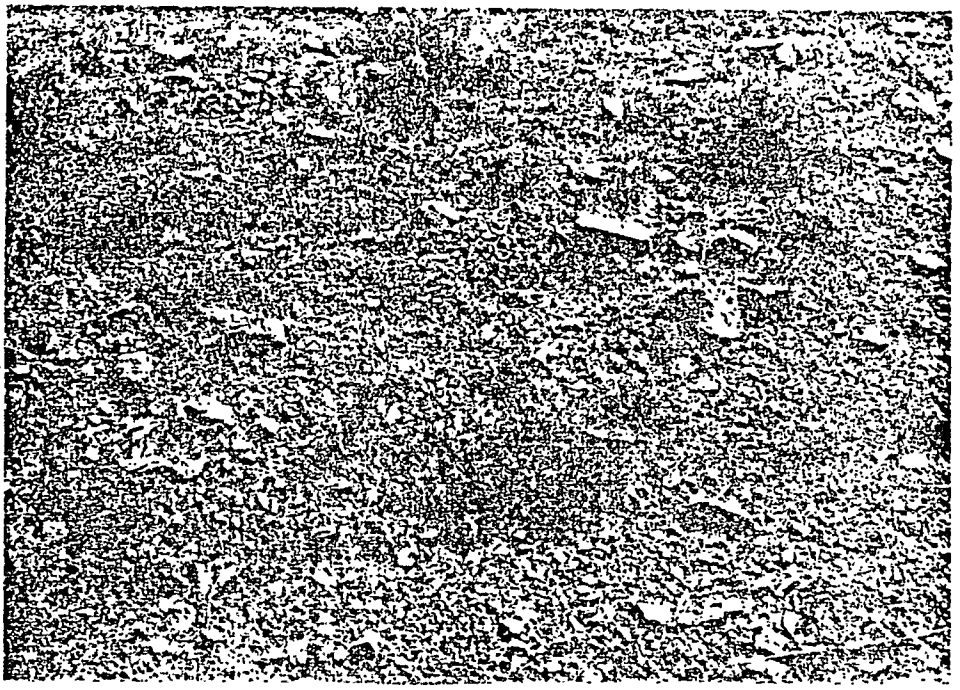


Photo #4. Antelope bitterbrush (plot 2 of original plots). Note plant density.

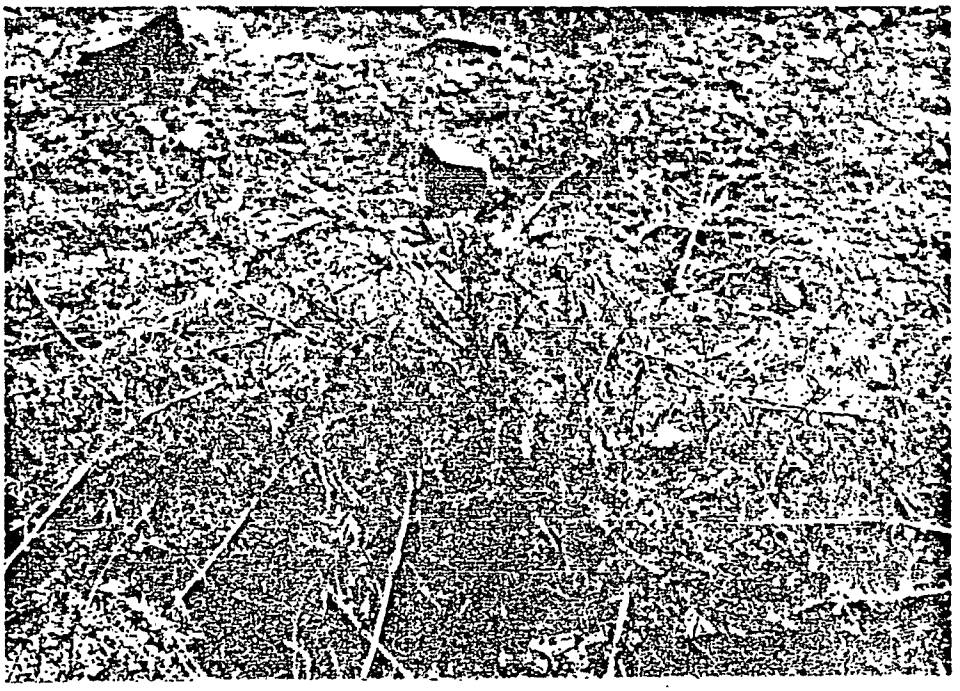


Photo #5. Antelope bitterbrush from original plots. Note flowers (arrows).

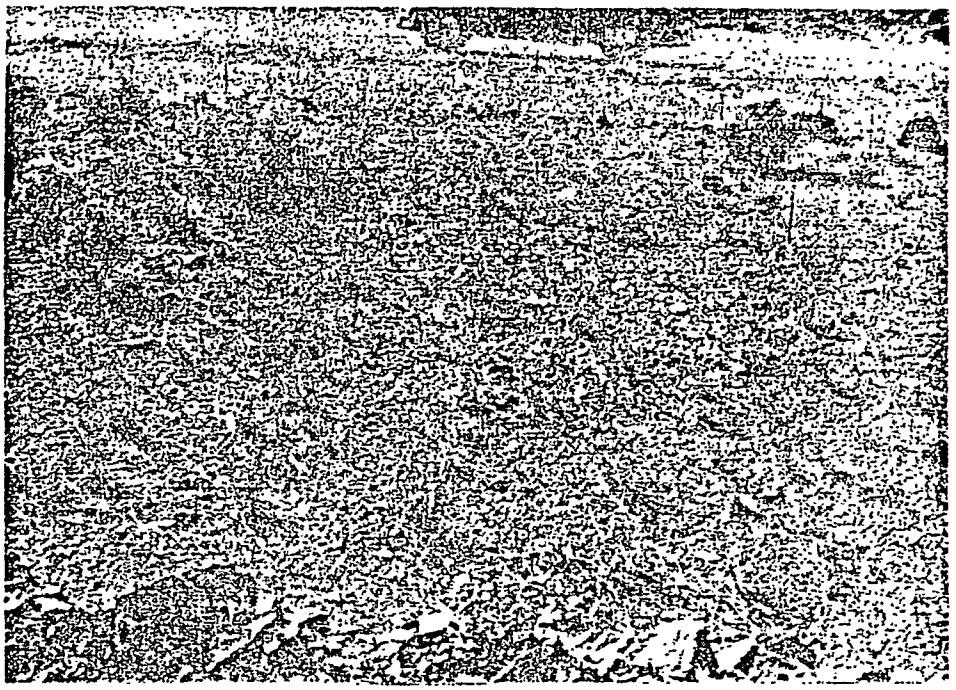


Photo #6. Tegmar intermediate wheatgrass on original plots. Note how plant growth is confined to rows.

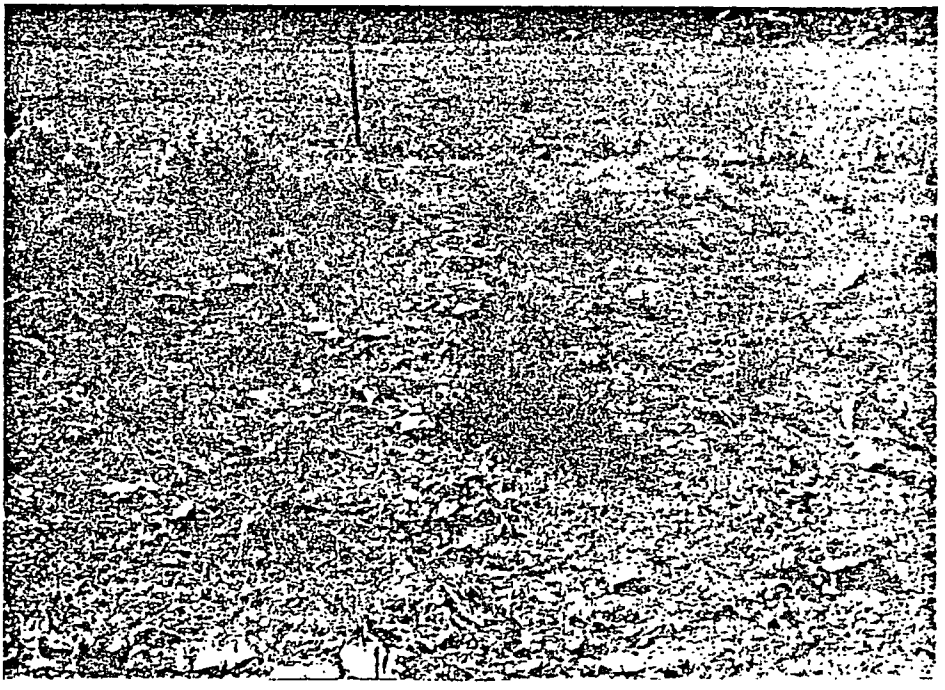


Photo # 7. Siberian wheatgrass on original plots.

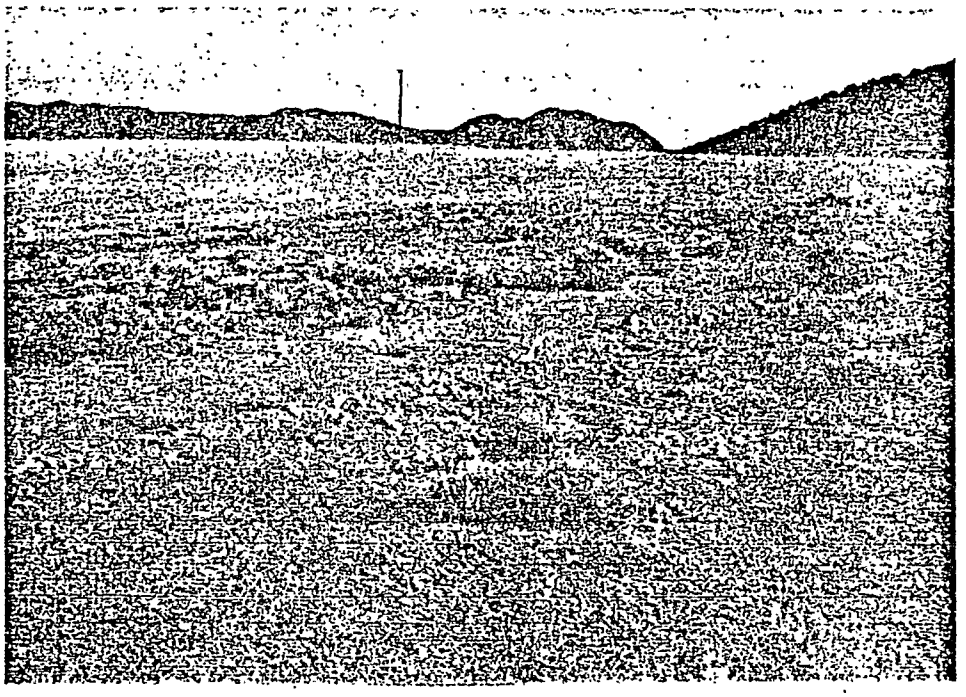


Photo #8. Overview of the original plot area. Note invasion of rabbitbrush over entire test area.

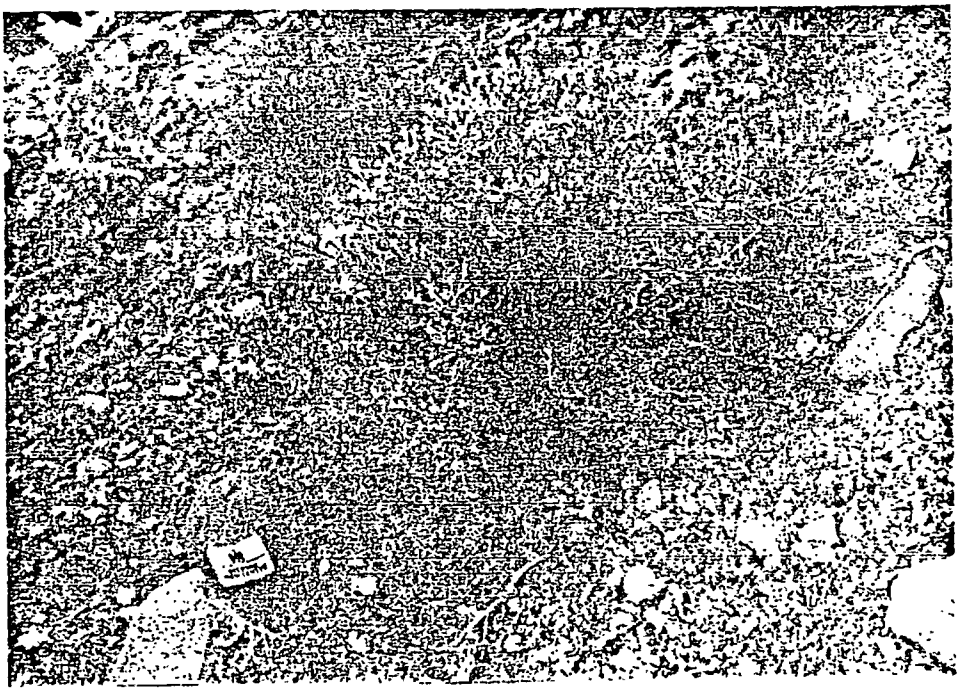


Photo #9. Antelope bitterbrush shrubs on unmodified slopes planted as seedling plugs. Note the good vigor of plants.

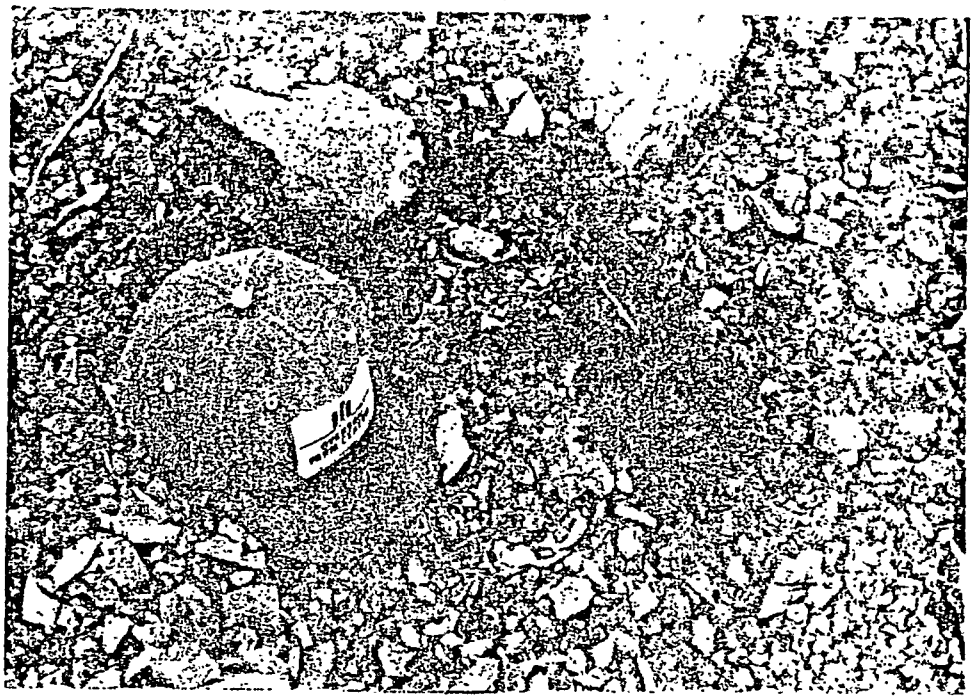


Photo #10. Squawbush seedling on modified slope test area. Planted as a seedling plug.

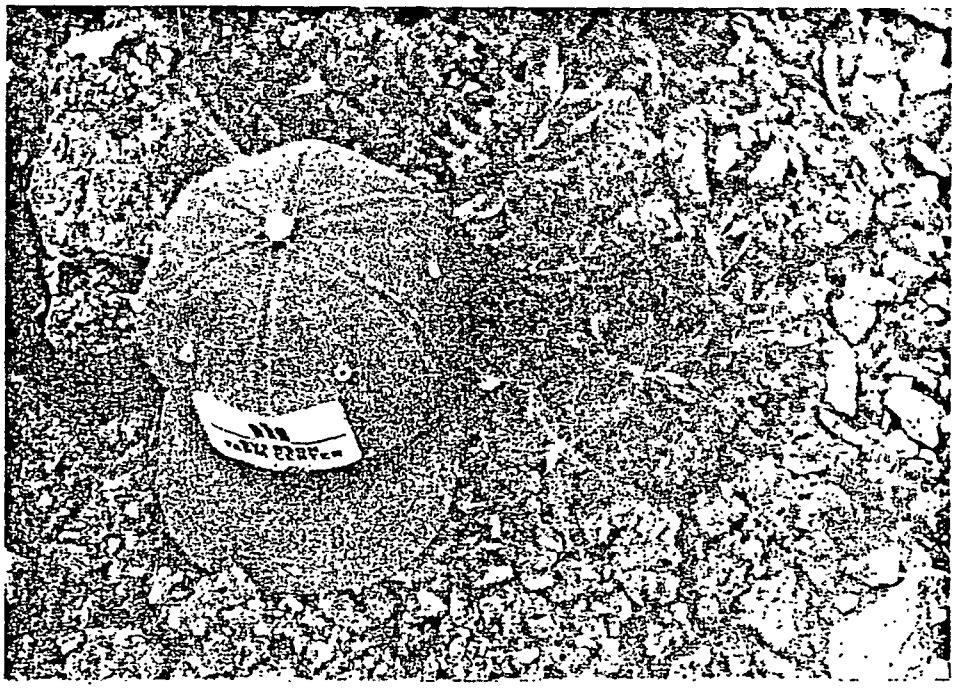


Photo #11. Fernbush seedling on modified slope. Planted as a seedling plug. Note the excellent vigor.

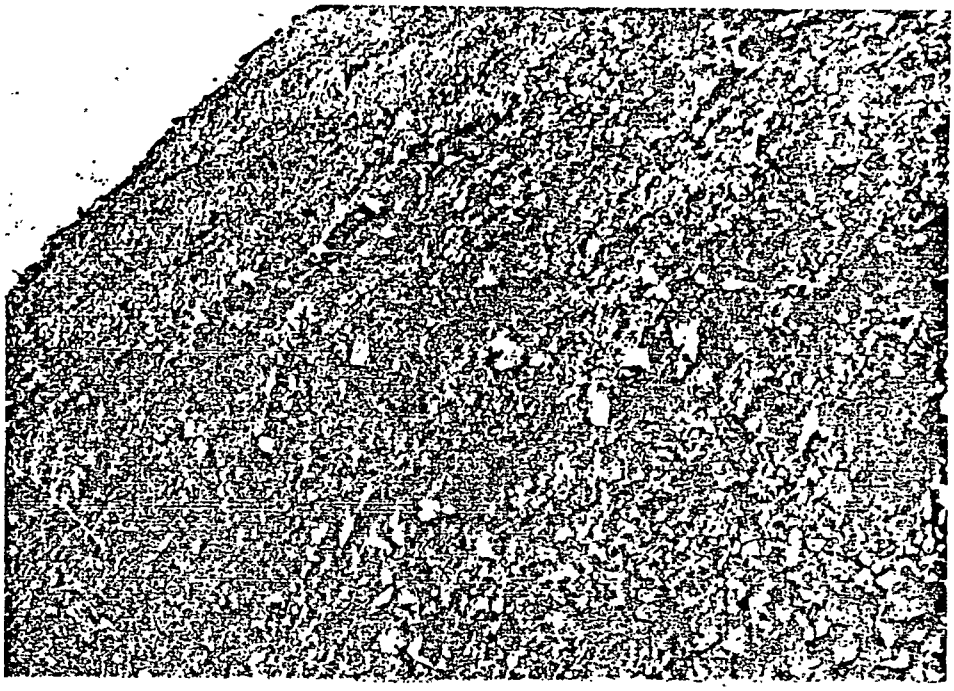


Photo #12. Fernbush test plot. Note the high rate of seedling survival.

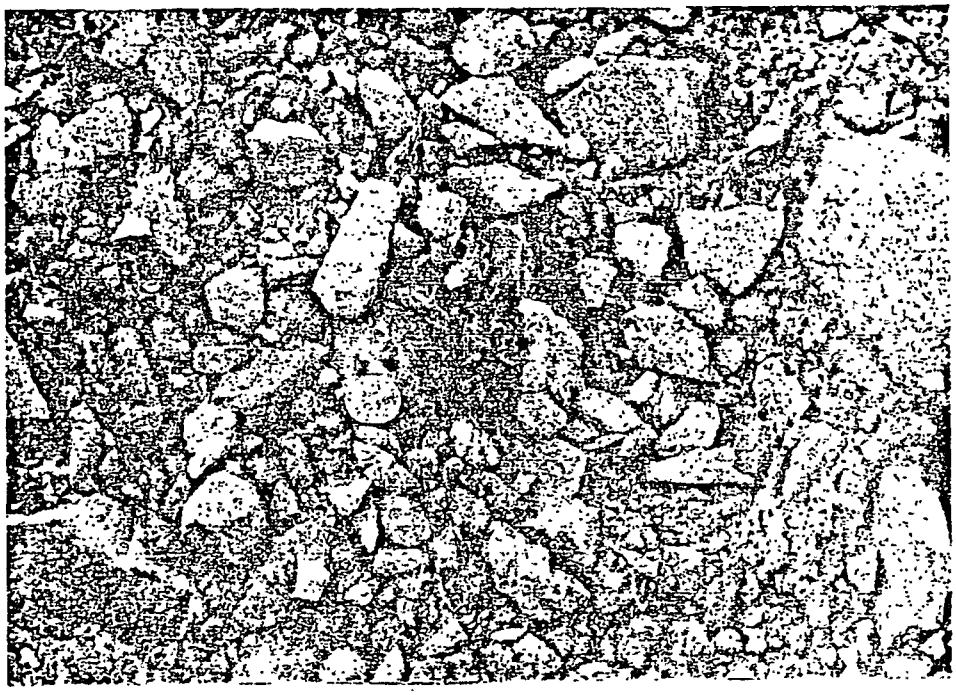


Photo #13. Antelope bitterbrush plant from seed on modified slope test area.

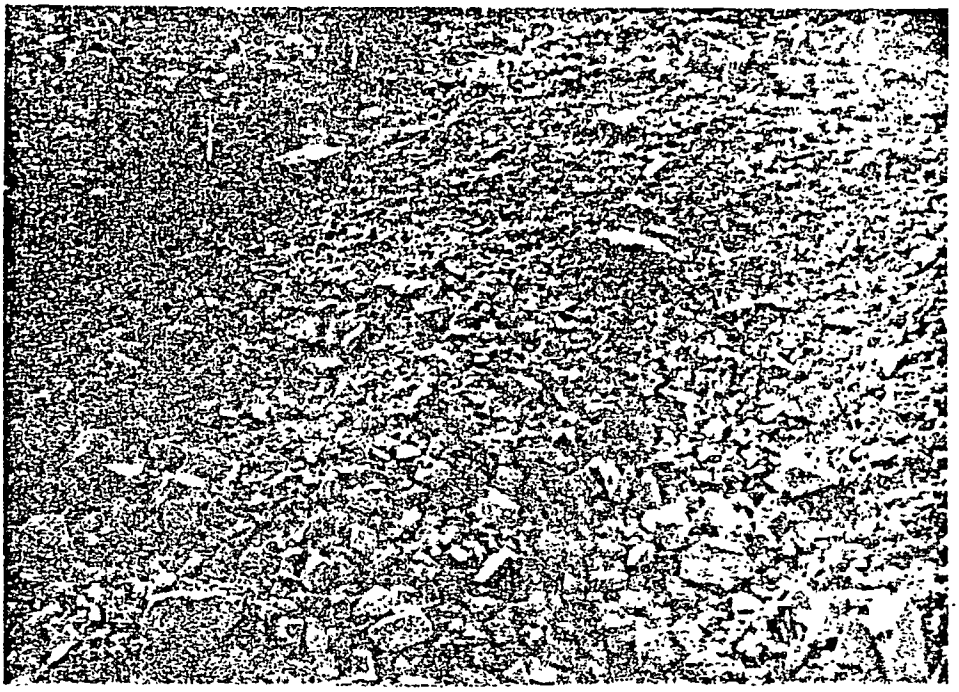


Photo #14. Intermediate wheatgrass from seed on modified slope test area.

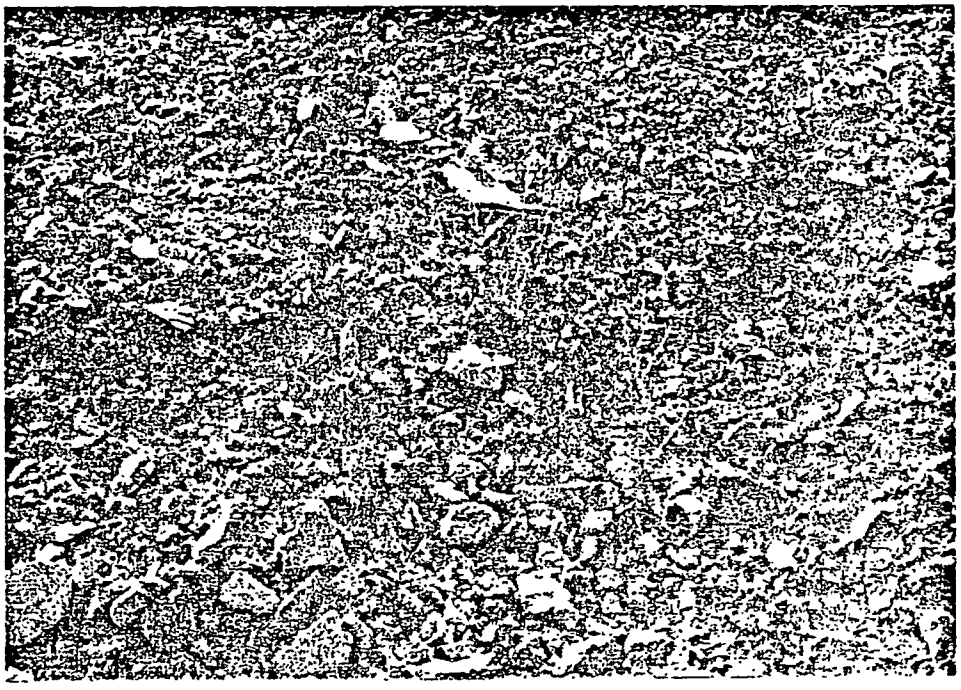


Photo #15. Siberian wheatgrass from seed on modified slope test area.

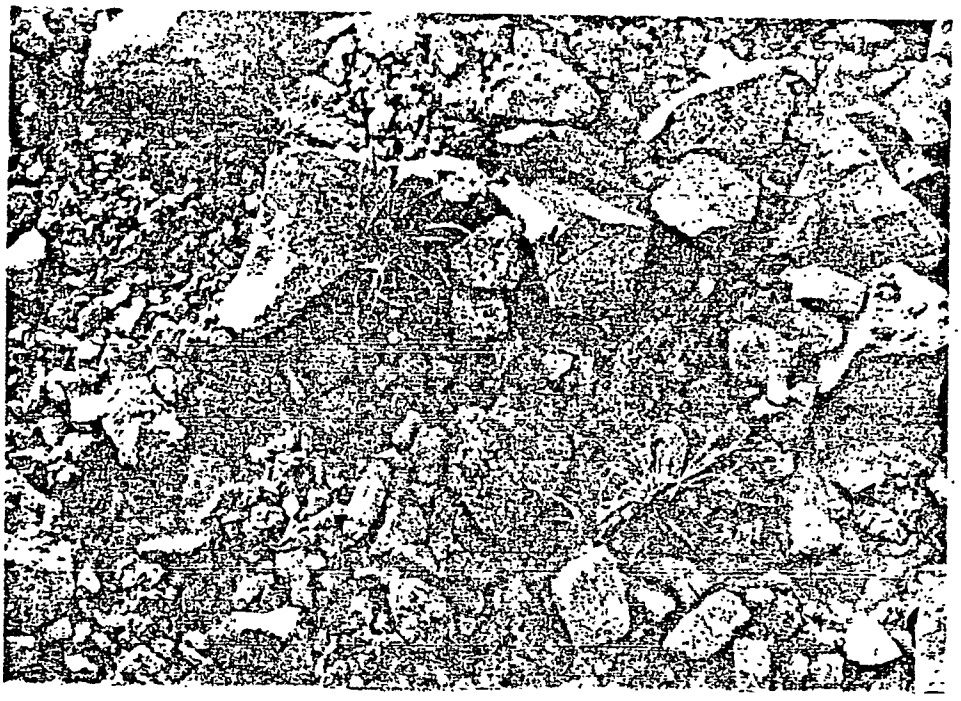


Photo #16. Russian wild rye from seed on modified slope test area.

Photo #17. Serviceberry from plugs on modified slope test area.

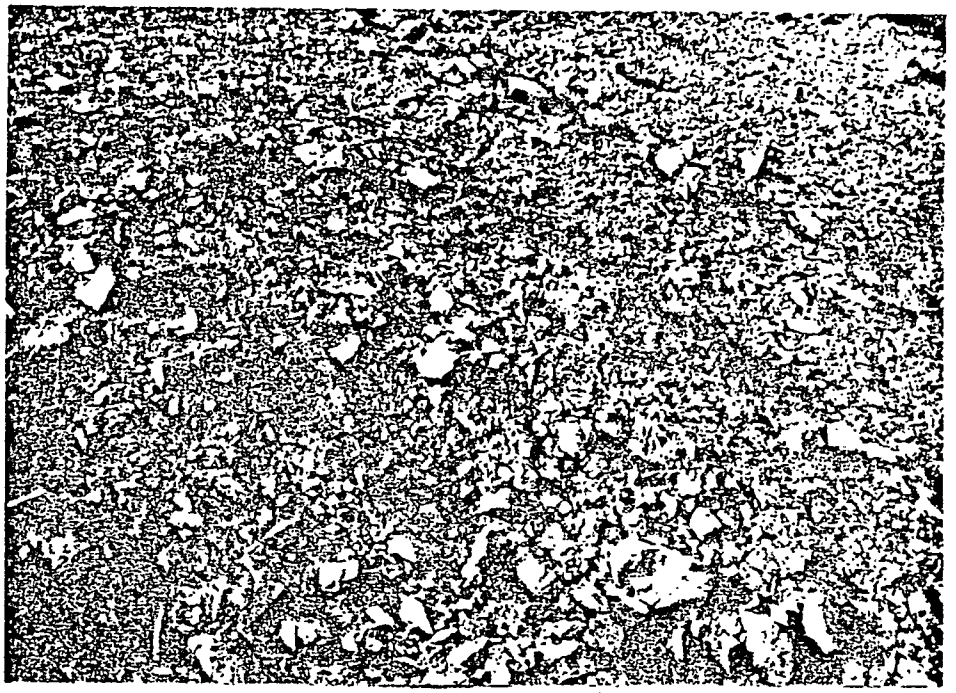


Photo #18. Rabbitbrush seedlings on the modified slope test area. These seedlings are from natural reseeding.

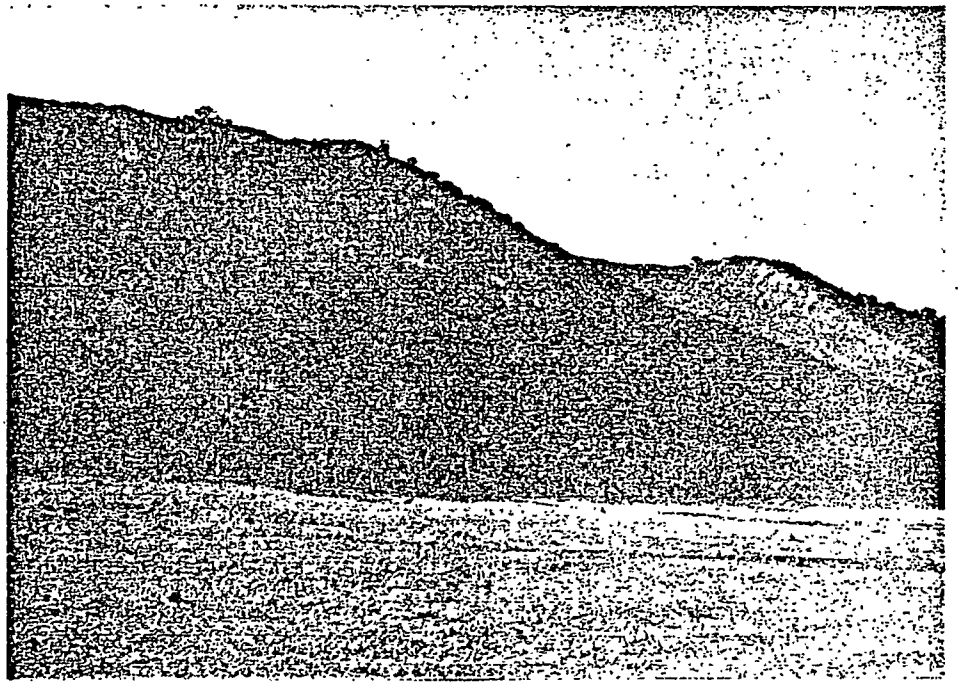


Photo #19. Modified and unmodified slopes. Note natural revegetation on unmodified slope.

Photo #20. Photo showing the seedbed of the original test plots on the mine dump tops. Scarification was minimal.

Preliminary Report of Seeding Overburden Deposits
at
Cedar City CF&I Mine

Justification

Iron mines in the Cedar City area are presently concerned with the reclamation of surface mined areas. The areas of major concern are those where large acreages of overburden have been deposited. It is not feasible to top dress these areas due to the dearth of topsoil on the unmined area. The areas requiring vegetation are, therefore, combinations of coarse and fine fragments in various proportions. Natural revegetation has been very slow and ground cover is inadequate to reduce or prevent soil erosion or provide forage for wildlife in the area. Plants that have reestablished naturally on the sites are: palmers penstemon (Penstemon palmeri), rubber rabbitbrush (Chrysothamnus nauseosus var. albicaulis), russian thistle (Salsola kali), indian ricegrass (Oryzopsis hymenoides), squirreltail grass (Sitanion hystrix), and four wing saltbush (Atriplex canescens).

It is the intent of this study to test various native and introduced plant species and determine their suitability for such reclamation projects.

Methods and Procedures

Eight (8) species of grasses, forbs and shrubs; tegmar intermediate wheatgrass (Agropyron intermedium), siberian wheatgrass (Agropyron sibericum), russian wildrye (Elymus junceus), yellow sweet clover (Melilotus officinale), white stem rabbitbrush (Chrysothamnus nauseous var albicaulis), antelope bitterbrush (Purshia tridentata), four wing saltbush (Atriplex canescens), and cliffrose (Cowania mexicana); were planted in a split plot randomized block design with two (2) replications on a level area of overburden deposits. Each species was planted in plots 30 feet by 10 feet with 4 foot buffer strips between each species. These plots were then divided into two 15 feet by 10

feet subplots. Half of each was then fertilized with 120 pounds of elemental nitrogen and 120 pounds of available phosphorus per acre in the form of ammonium nitrate and treble super phosphate. Fertilizers were broadcast with a cyclone seeder on July 11, 1977. Seeds broadcast on July 22, 1977 at the rates shown in table 1.

Plots were permanently marked with metal stakes. Seed and fertilizer were manually raked into the soil. The test site was irrigated four times by CF&I personnel as an aid to seed germination and seedling emergence.

Plant response was measured in October and November at regular intervals along five (5) line transects located in each plot. Data, taken with one square foot plots, included density (number of plants per square foot), cover (estimated), average height of plants, and frequency (number of plots that a plant occurs in).

Rain gauge data was collected daily and furnished to us by Mr. Jim Hale.

Results

Table 1 shows the results of plant response. It is apparent from this table that the grasses were the most successful species at the end of the growing season. Yellow sweet clover, a biennial, was also abundant, but the only shrub to produce seedlings was four wing saltbush. Antelope bitterbrush, and cliffrose require stratification (cold moist treatment) before germination will occur. Therefore these species did not germinate this year but probably will next year. Rabbit brush must also have a dormant seed and the success of this species will also be evaluated next summer. Two plants of rabbitbrush were found in the plots but these were volunteer plants and not a result of the seeding. Cover and average height were of minor value at this early stage of plant development, therefore not included in this table. The dominant annual in the plots was the introduced russian thistle (Salsola kali). This plant was very abundant, but did not appear to suppress the other seedlings.

TABLE 1

Seedling emergence. Total values for Fertilized and Unfertilized treatments. Plants ranked according to success.

Species	Seeding Rate	Fertilized		Unfertilized	
		Density (Plants/sq.ft.)	Frequency	Density (Plants/sq.ft.)	Frequency
Tegmar Intermediate Wheatgrass	20 lbs/a	1.26	74%	1.72	86%
Siberian Wheatgrass	16 lbs/a	1.33	86%	1.55	78%
Russian Wildrye	20 lbs/a	1.00	80%	0.68	96%
Yellow Sweet Clover	8 lbs/a	0.48	76%	0.88	80%
4 Wing Salt Bush	10 lbs/a	0.03	18%	0.04	18%
White Stem Rabbitbrush	4 lbs/a	0.003	2%	0.003	2%
Antelope Bitterbrush	12 lbs/a	-	-	-	-
Cliffrose	12 lba/a	-	-	-	-

Precipitation data for the period of study is included in Table 2.

TABLE 2

Total monthly precipitation during the period July through December in inches:

July	August	September	October	November	December
0.47	1.89	0.85	0.43	0.45	0.56

Summary

Favorable results were obtained from the three grass species and the yellow sweet clover. Density of these species is probably higher than can be maintained on this site once the plants reach maturity. No seed germination or seedling emergence was apparent with any shrubs other than four wing saltbush. Although the density of four wing saltbush is 3 plants per 100 sq. ft. these plants attain a large stature and will add materially to the plant cover of this area. It has been well documented that bitterbrush and cliffrose produce dormant seeds which must undergo stratification prior to germination. This requirement should be met by the seeds overwintering in the soil, and germination should occur next spring. It is also anticipated that white stem rabbitbrush will germinate in the spring.

Fertilization is apparently of no benefit to germination or emergence of the tested species. In fact density is higher on the unfertilized plots of some species.

July seeding is not the optimum period for seeding these areas and the results presented here must be accepted as preliminary. Further evaluations will be made throughout the growing season of 1978.

Revegetation of Overburden Deposits at Cedar City CF&I Mine - Phase II

Progress Report

The revegetation studies begun in 1977 by a Southern Utah State College team of researchers were expanded in 1978 and 1979 to include revegetation of the steep dump slopes. A variety of methods were used along with a greater variety of plant species. A final report of the results will be written at the end of the current growing season. Work completed to date includes the following:

A. Plugging - Shrub species.

In the fall of 1978, plugs (see photos 1 & 2) of selected plant species were planted on permanent plots, marked by steel pegs, on the slope of a mine dump. The permanent plots were arranged from the top of the slope toward the bottom and placed in such a manner as to utilize both the finer tailings and some of those made up of larger rocks. The areas composed entirely of the large boulders were avoided at this time.

The plants, purchased from a commercial supplier, included the following shrub species: Rabbitbrush (Chrysothamnus nauseosus), Four-wing Saltbush (Atriplex canescens), Bitterbrush (Purshia tridentata), Fernbush (Chamaebatiaria millefolium) and Squawbush (Rhus trilobata). These shrubs were selected because they are native to the immediate area.

Placements of the plots within each treatment (finer soil or coarse, rocky material) was at random. Each plot consisted of a single shrub species and was replicated twice. The arrangement

of the plots in each treatment is as diagramed below: (see photos 3 & 4).

Top of Slope

(Finer tailings)

Rabbit brush	Four-wing Saltbush
Bitterbrush	Fernbush
Fernbush	Squawbush
Squawbush	Bitterbrush
Four-wing Saltbush	Rabbit brush

(Coarse tailings)

Four-wing Saltbush	Bitterbrush
Rabbit brush	Squawbush
Squawbush	Rabbit brush
Fernbush	Four-wing Saltbush
Bitterbrush	Fernbush

Bottom of slope

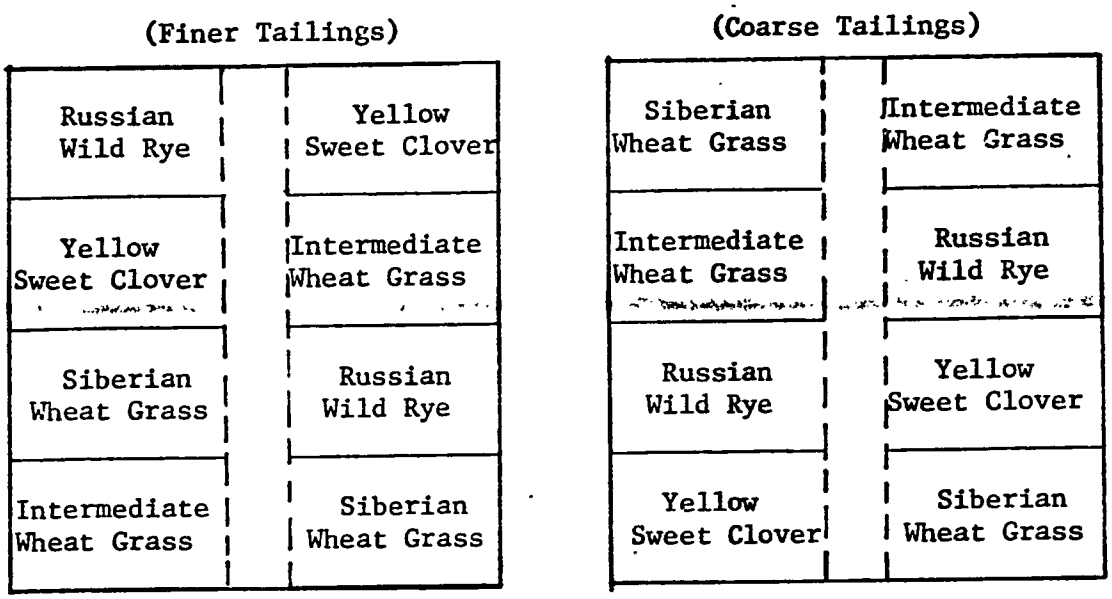
Ten plants were planted by hand in each plot. The plots have been checked for plant survival and growth twice to this point, once in May and again in July. They will be checked again this fall at the end of the growing season.

B. Broadcasting - Grass varieties and Yellow Sweet Clover

Selected grass varieties and yellow clover were broadcast on plots which were arranged similar to those of the shrubs, top of slope to the bottom. The plots were lightly raked after seed application. The grass species used were: Russian wild rye, Siberian wheat grass and Intermediate wheat grass. Yellow sweet clover was also planted.

. The plots were arranged within the two treatments as diagramed below: (See photos 5 & 6).

Top of Slope



Bottom of Slope

The results of this planting method will be calculated at the end of the growing season and comparisons made with the hydro-mulch technique.

C. Hydromulch - Grass varieties and Yellow Sweet Clover

The above-mentioned grass varieties and the Yellow Sweet Clover were applied to the plots using a Spray-Baby Hydromulcher with a Kaibab organic mulch. The plots were arranged parallel with the slope base to facilitate seed-mulch application. (See photos 7 & 8). The plots crossed both coarse and fine overburden. Plot arrangement was as diagramed in the following:

Rock		Fine				Rock	
Yellow Sweet Clover	Russian Wild Rye	Intermed. Wheat Grass	Yellow Sweet Clover	Russian Wild Rye	Siberian Wheat Grass	Siberian Wheat Grass	Intermed. Wheat Grass

Rock	Fine			Rock	Fine	Rock	rock
Intermed. Wheat Grass	Yellow Sweet Clover	Russian Wild Rye	Siberian Wheat Grass	Yellow Sweet Clover	Intermed. Wheat Grass	Siberian Wheat Grass	Russian Wild Rye

Planting took place in May of 1979. The germination and growth results will be determined at the close of the current growing season.

In the Future:

There are a number of revegetation techniques which we as a research team would like to pursue in the future, depending, of course, on the willingness of CF&I to participate. Some of these techniques could include:

A. Terracing for better water conservation and ease of planting.

B. Top-dressing rockier areas with fine overburden prior to planting.

C. More extensive use of hydromulch with grasses and shrubs.

D. More extensive use of herb and grass species.

E. Succession techniques - first using annuals to alter and prepare areas for successive planting of perennials.

F. Investigate methods of hastening the natural revegetation of the area. Some areas are now revegetating on their own.

G. Investigate effectiveness and practicality of synthetic water-conserving substances such as Viterra 2 Hydrogel Soil Amendment.

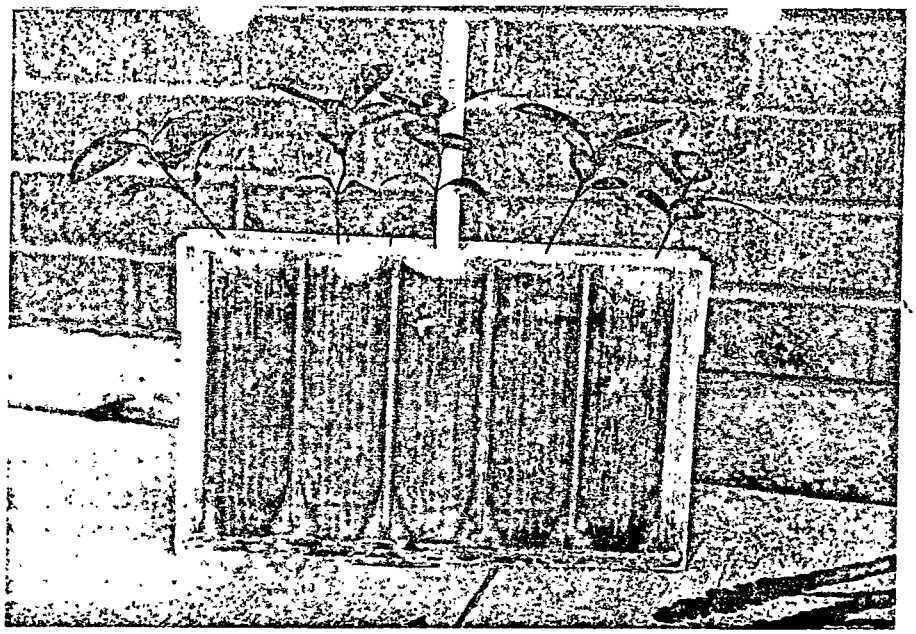


PHOTO 1

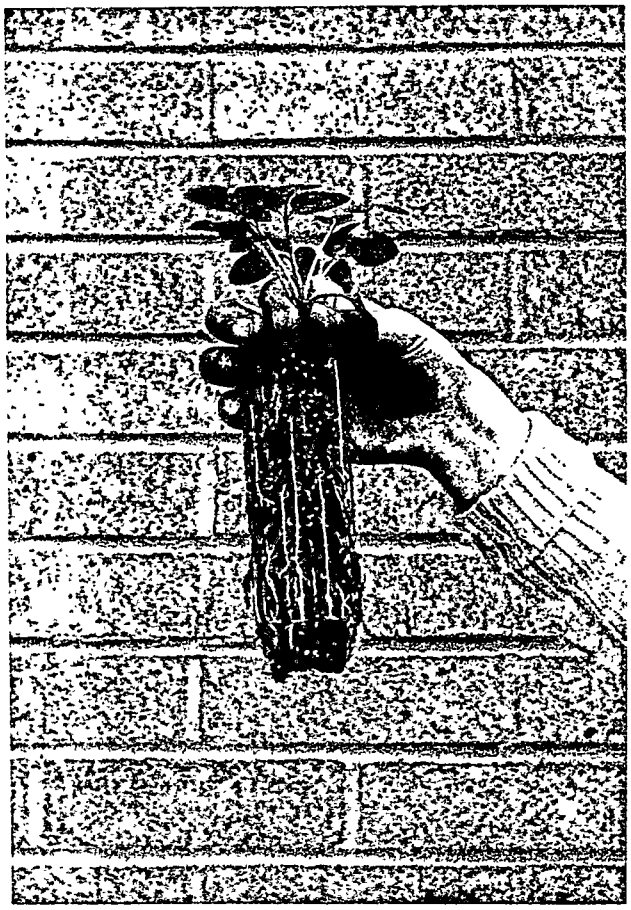
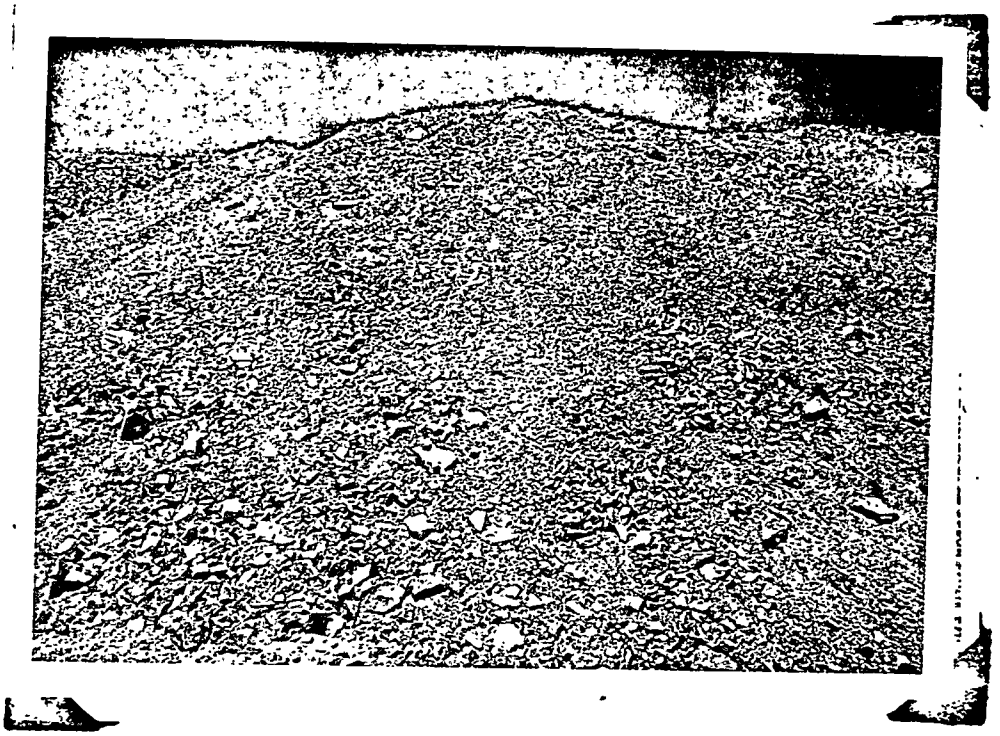


PHOTO 2

Photo 3



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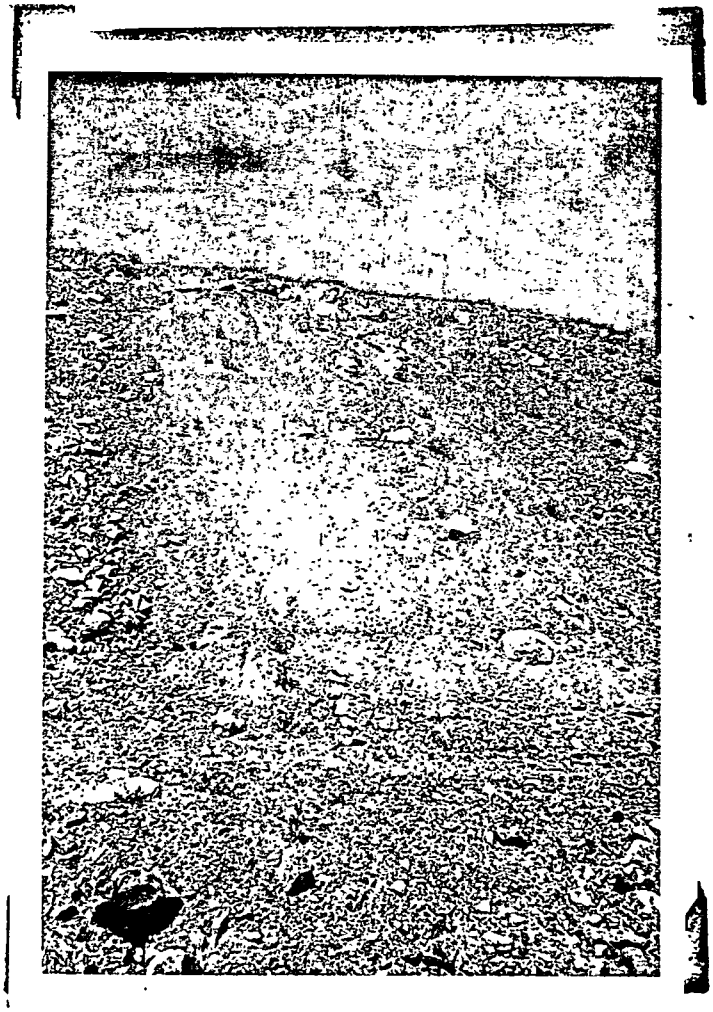

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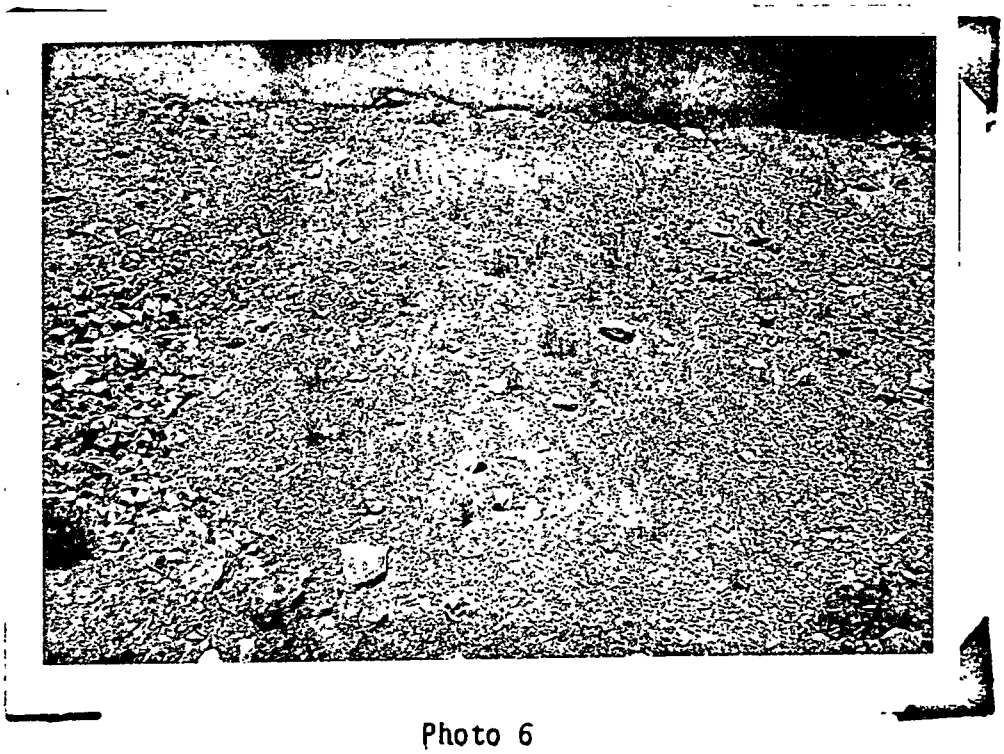


Photo 6

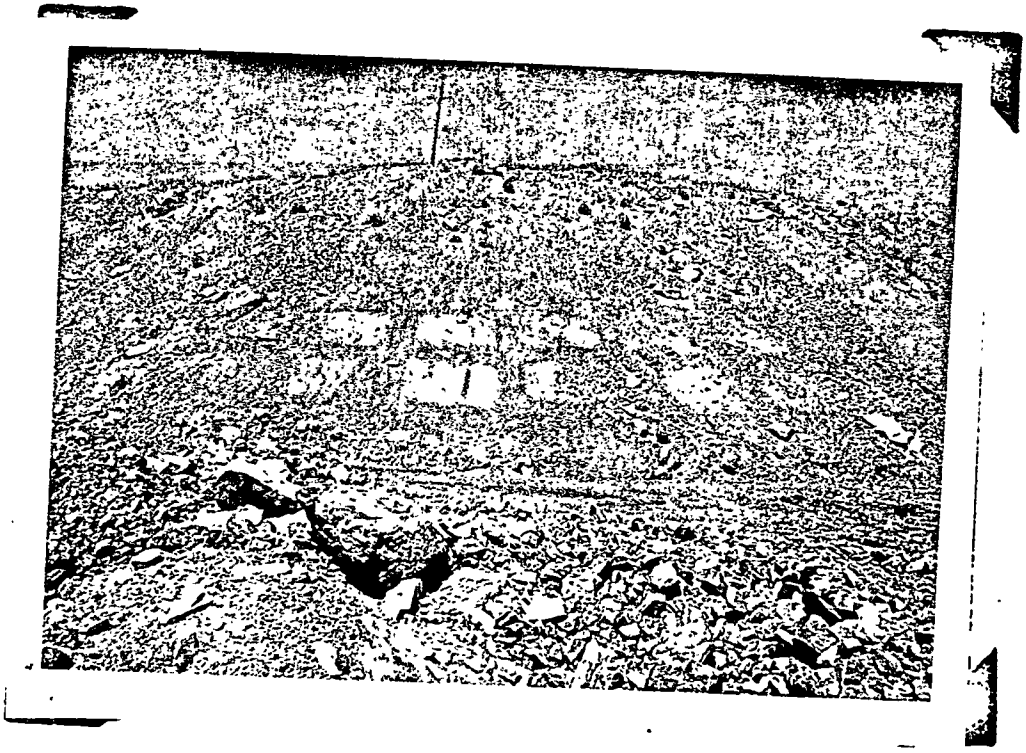


Photo 7

Revegetation of Overburden Deposits at Cedar City CF&I Mine - Phase III

During the past 2 years of revegetation studies at the CF&I Comstock Mine near Cedar City several shrubs and grasses have shown favorable germination and growth. In light of the data collected (see Progress Report Phase I & II), the research team would like to propose several modifications and variations of processes tested, and would like to introduce one new species of shrub.

Discussion

During May of 1978, three grasses (Russian Wild Rye, Intermediate Wheat Grass, Siberian Wheat Grass) and Yellow Sweet Clover were applied in sixteen plots by the hydromulch spraying method. Germination and growth of these seeds was analyzed in July and again in September. None of the seeds had germinated as of September. It was felt that this was due to the inadequate precipitation during the spring, summer and fall. Followup investigation on germination will be made in late fall (end of October or early November), and in the spring (April or May). It is felt that germination could still occur and that meaningful data could be collected from this application.

Testing the application of seed by hydromulch should be continued and a fall application could provide valuable information as to the timing of application.

We are proposing to repeat the hydromulch seeding of grasses and clover at a new site in the exact manner that it was applied during the spring.

The shrub species seeded in Phase I have been re-analyzed. Two species, Rabbitbrush and Bitterbrush, show good growth. These shrubs and Fernbush, planted as plugs in Phase II, are showing excellent survival at this date.

Shrubs have not been tested on the slopes in the form of seeds. After re-analyzing the plots on level ground, which were planted in Phase I and the plugs planted in Phase II, we are proposing that all shrubs tested by seed and by plugging should be repeated on the slopes in the form of seed broadcasting.

The testing of shrub seeds on the slopes may lead to the most economical method of large-scale revegetation. These species include Bitterbrush, Rabbitbrush, Fernbush, Four-wing salt brush, Squaw bush.

Kochia prostrata, an introduced shrub, has come to the attention of the research team. This species has been reported as a drought-hardy plant with exceptional growth potential on disturbed sites. We would like to include this species in our tests. Small amounts of seed are available and will be provided by the Forest Service. We will plant this shrub, along with our other shrubs on the slopes and grow 50 plugs in the greenhouse, to be planted in the spring of 1980.

Natural revegetation has occurred on some slopes and level areas, the most prevalent species involved being Rabbitbrush. As suggested in our last progress report, techniques to hasten this natural revegetation should be investigated.

Clipping or brush beating has been used in nonsprouting plants as a method of control. We feel that clipping or cutting back of Rabbitbrush, a sprouting species, would have a beneficial effect of increasing cover and growth.

Two plots 20' x 20' will be established on the level area above the present test slopes. One will be clipped, the other used as a control.

ACT/021/005

Proposed Revegetation of Overburden Deposits at Cedar City CF&I Mine

Submitted: Southern Utah State College Division of Life Science

Justification:

Iron mines in the Cedar City area are presently concerned with the reclamation of surface mined areas. The areas of major concern are those where large acreages of overburden have been deposited. It is not feasible to top dress these areas due to the dearth of topsoil on the unmined area. The areas requiring vegetation are, therefore, combinations of coarse and fine fragments in various proportions. Natural revegetation has been very slow and ground cover is inadequate to reduce or prevent soil erosion or provide forage for wildlife in the area. Plants that have reestablished naturally on the sites are: palmers penstemon (Penstemon palmeri), rubber rabbitbrush (Chrysothamnus nauseosus var. albicaulis), russian thistle (Salsola kali), indian ricegrass (Oryzopsis hymenoides), squirreltail grass (Sitanion hystrix), and four wing saltbrush (Atriplex canescens),

It is the intent of this proposal to test various native and introduced plant species and determine their suitability for such reclamation projects.

Methods and procedures:

The initial proposal will test eight (8) plant species that appear suitable in regard to establishment, erosion control, and palatability to wildlife. The test plants will be seeded in plots 30 feet long and 8 feet wide in a randomized block design with 4 foot buffer strips between each species. Nitrogen and phosphorus fertilizers will be applied to each treatment in a split-plot design at the rates of 120 lbs. of elemental nitrogen plus 120 lbs. of available phosphorus per acre. The experimental design will include two replications.

Attachment "H"

Selected species, assuming seed source availability, will include: four wing saltbrush, Utah serviceberry, antelope bitterbrush, yellow sweet clover, white stem rubber rabbitbrush, tegmar intermediate wheatgrass, russian wildgrass, and siberian wheatgrass.

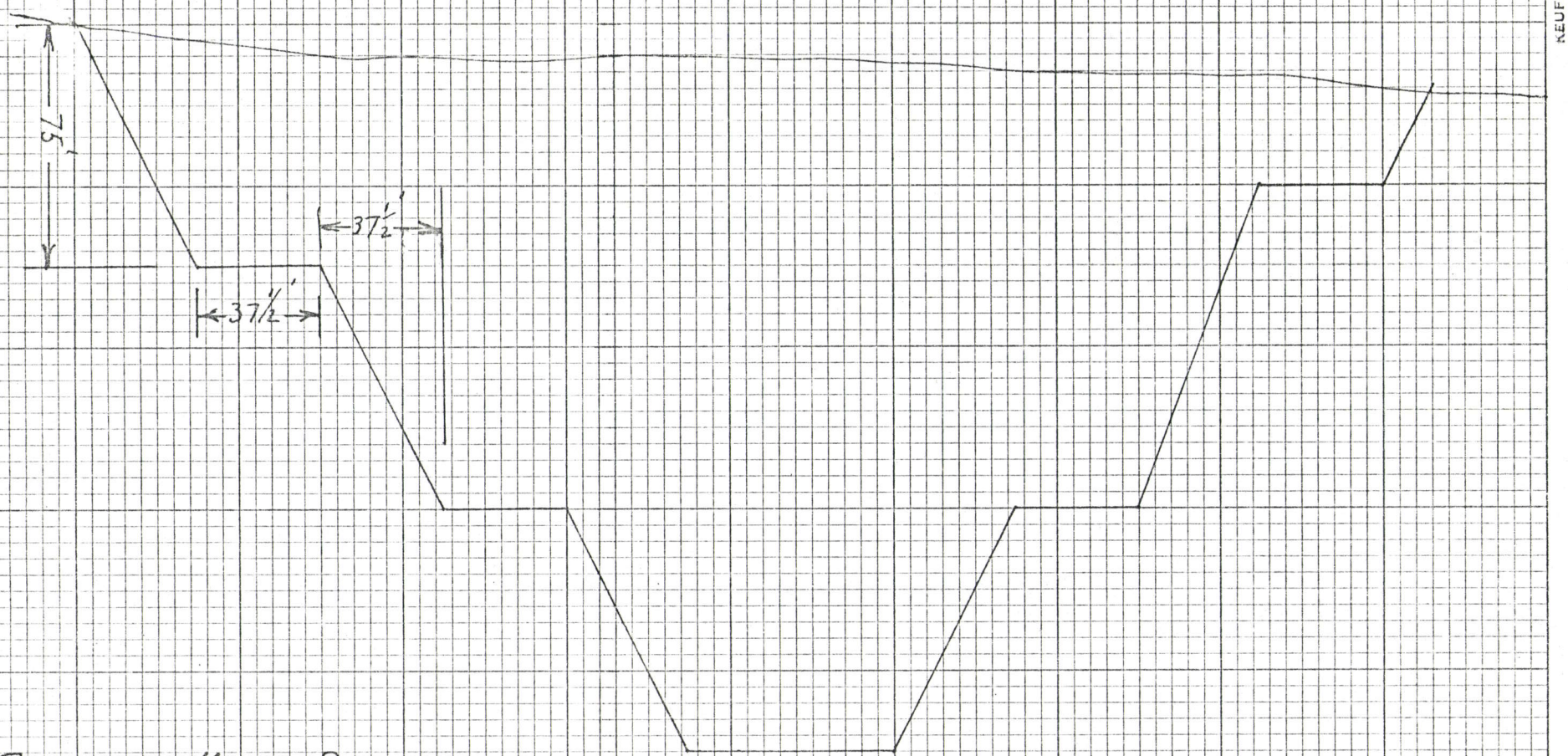
The experimental area will be prepared to our specifications by CF&I personnel and equipment. Seed will be broadcast and hand raked to insure adequate soil coverage. Seeding rates will follow recommendations in Technical Note "Guidelines for Reclamation of Surface Mined Areas in Utah" SCS, USDA. Test plots will be irrigated at a rate that will insure that the plantings are not damaged and at intervals which will provide optimum germination, establishment, and growth. Details will be worked out between SUSC researchers and Mr. James E. Hale, CF&I project engineer.

Plots will be permanently located with 2 foot lengths of reinforcing steel. Observations will be made throughout the growing season and evaluations will be conducted at the end of the growing season. Results and recommendations will then be provided to Mr. Hale.

ESTIMATED COSTS

Sixty four feet 3/8" reinforcing steel cut into 2 foot lengths	$ 5.94
Four garden rakes	$ 37.96
One roll 1/4 inch twine (320 ft.)	$ 5.00
Mileage	$ 200.00
Salaries: 36 man days @$10.00/hr app	$3,000.00
Secretarial	$ 50.00
Seed costs	$ 28.00
Fertilizer	$ 13.00
Fringe Benefits (19.0%)	$ 579.50
Indirect Costs (12.0%)	$ 435.48
Total Estimated Cost	$4,354.88

ACT/021/005



COMSTOCK MINING PLAN

TYPIFIED CROSS SECTION

1" = 50' MAY 1977

ATTACHMENT F

Sc 1 Profile ACT/021/005

LMC LM gravelly sandy loam, 4 to 8 percent slopes

The soil represented by this symbol on the photo is deep, and well drained. Slopes range from 4 to 8 percent. Typically, the surface layer is a brown gravelly sandy loam that contains 20 to 25 percent gravel. It is 2 to 3 inches thick. The subsoil or next underlying layer is a dark brown gravelly sandy clay loam that contains 20 to 25 percent gravel and 0 to 5 percent cobble. It is 6 to 16 inches thick. The second underlying layer is a brown and pinkish white gravelly sandy clay loam and gravelly sandy loam containing 20 to 30 percent gravel and is underlain by a carbonate cemented hardpan at about 50 inches. Permeability is moderately slow, runoff is medium and the erosion hazard is moderate. Available water holding capacity is 6 to 7 inches and the water supplying capacity is 7 to 8 inches annually.

The soil formed in alluvium from intermediate igneous rock. It occurs on alluvial fans in the west part of the survey area. Elevation ranges from 5,550 to 6,000 feet. The vegetation is dominantly juniper, pinyon pine, cliffrose, prickly pear, snakeweek, penstemon, needleandthread, threeawn, galleta and Indian ricegrass.

The climate is dry subhumid. Average annual precipitation is 11 to 13 inches, mean annual temperature is 49° to 51° F., and the frost-free period is 115 to 135 days. The soil is used for livestock grazing and wildlife habitat.

Texture of the subsoil ranges from gravelly sandy clay loam to gravelly clay loam. Rock fragments range from 0 to 5 percent cobble and 20 to 30 percent gravel. Rock fragment content of the second underlying layer ranges from 0 to 5 percent cobble and 20 to 40 percent gravel. The carbonates have been leached out of the surface and subsoil and redeposited in the underlying layers at depth ranging from 16 to 18 inches below the surface. In much of the area, a carbonate cemented hardpan does not occur.

Included with this unit in mapping are small areas of CM gravelly loam, 2 to 5 percent slopes, small areas of Kd loam, 2 to 5 percent slopes, and small areas of Motoqua very cobbly sandy loam, 8 to 25 percent slopes.

A representative profile in a noncultivated areas, located about 3 miles southeast of Desert Mound, near the center of Section 15, T. 36 S., R. 13 W., follows (Profile No. 507):

A1	0-5 cm 0-2"	Brown (7.5YR 5/2) gravelly light sandy loam, dark brown (7.5YR 3/2) moist; weak very thin platy structure that parts to moderate medium and fine subangular blocky structure; sofe, very friable, nonsticky, nonplastic; few fine and very fine roots; few medium and fine and many very fine and micro vesicular pores; 20 to 25 percent gravel and 0 to 5 percent cobble; noncalcareous; moderately alkaline (pH 8.0); clear smooth boundary.
B2t	5-46 cm 2-18	Dark brown (7.2YR 4/3) gravelly sandy clay loam, dark brown (7.5YR 3/3) moist; moderate coarse

Attachment "6"

		subangular blocky structure that parts to moderate medium and fine subangular blocky; hard, firm, sticky, plastic; few medium, fine and very fine roots; few fine, common very fine and many micro tubular pores; common thin clay bridges on ped faces and in pores; 20 to 25 percent gravel and 0 to 5 percent cobble; noncalcareous; moderately alkaline (pH 8.0); clear smooth boundary.
C1ca	46-76 cm 18-30"	Brown (7.5YR 5/3) gravelly light sandy clay loam, dark brown (7.5YR 4/3) moist; massive; hard, friable, slightly sticky, slightly plastic; few very fine roots; many very fine and micro pores; 20 to 30 percent gravel; strongly calcareous, lime is disseminated and also in thin filaments; moderately alkaline (pH 8.4); clear wavy boundary.
C2ca	76-109 cm 30-43"	Brown (7.5YR 5/4) gravelly sandy clay loam, dark brown (7.5YR 4/4) moist; massive; hard, firm, sticky, plastic; few very fine roots; many very fine and micro tubular pores; 20 to 30 percent gravel; strongly calcareous, lime is disseminated and also in thin filaments; strongly alkaline (pH 8.8); clear, smooth boundary.
C3ca	109-127 cm 43-50"	Pinkish-white (7.5YR 8/2) gravelly sandy loam, (7.5YR 7/3) moist; massive; moderately cemented, friable, nonsticky, nonplastic; few very fine roots; few very fine and micro tubular and interstitial pores; 20 to 30 percent gravel; very strongly calcareous, lime is disseminated and moderately cemented; very strongly alkaline (pH 9.2); abrupt, smooth boundary.
C4cam	127 cm 50"	Carbonate cemented hardpan.

This soil is classified as fine-loamy, mixed, mesic family of Aridic Calcic Argixerolls. It is in the Upland Loam (Juniper-Pinyon) range site.

CJ very cobbly loam, 30 to 50 percent slopes.

Typically gravel and cobble cover 70 to 80 percent of the surface forming a pavement. The surface layer is a brown very cobbly loam containing 30 to 40 percent cobble and 20 to 30 percent gravel. It is 3 to 4 inches thick. The subsoil or next underlying layer is a brown and yellowish red gravelly clay loam containing 5 to 20 percent cobble and 25 to 40 percent gravel. This soil material extends to a depth of 60 inches or more. Permeability is moderately slow, runoff is slow and the erosion hazard is slight. The available water holding capacity is 6 to 7 inches and water supplying capacity is 8 to 10 inches.

Rock fragments in the surface layer range from 10 to 40 percent cobble and 20 to 40 percent gravel. The texture of subsoil ranges from gravelly clay loam to very cobbly clay loam, very gravelly clay loam and cobbly clay loam. Rock fragments range from 5 to 50 percent cobble and 15 to 40 percent gravel.

A representative profile in a noncultivated area is located near the center of the Antelope mountain range: SE 1/4 of Section 32, T. 35 S., R. 14 W.; photo location 14AA-30-J-7, profile number 483.

A1	0-10 cm 0-4"	Brown (10YR 5/3) very cobbly loam, very dark brown (7.5YR 2/2) moist; weak fine granular structure; soft, friable, slightly sticky, slightly plastic; few coarse and medium, common fine and many very fine roots; few medium, common fine and many very fine random tubular pores; 30 to 40 percent cobble and 20 to 30 percent gravel; noncalcareous; neutral (pH 7.2); clear, smooth boundary.
B1	10-28 cm 4-11"	Brown (10YR 5/3) gravelly heavy loam, very dark brown (7.5YR 2/2) moist; moderate very fine granular structure; soft, friable, sticky, slightly plastic; few medium and fine and common very fine roots; few medium and common fine and very fine random tubular pores; 15 to 20 percent cobble and 20 to 30 percent gravel; noncalcareous; mildly alkaline (pH 7.4); clear, wavy boundary.
B21t	28-38 cm 11-15"	Brown (7.5YR 5/3) gravelly clay loam, dark brown (7.5YR 3/3) moist; moderate medium subangular blocky structure that parts to moderate very fine subangular blocky; hard, firm, sticky, plastic; few medium and fine and common very fine roots; few medium, common fine and many very fine pores; few thin clay films on ped faces and rock fragments; 5 to 10 percent cobble and 25 to 30 percent gravel; noncalcareous; mildly alkaline (pH 7.6); clear, irregular boundary.
B22t	38-63 cm 15-25"	Brown (7.5YR 5/4) gravelly clay loam, dark brown (7.5YR 3/4) moist; moderate medium subangular blocky structure that parts to moderate very fine subangular blocky; hard, firm, sticky, plastic;

few medium, fine and very fine roots; few medium, common fine and many very fine random tubular pores; common moderately thick clay films on ped faces and on rock fragments; 15 to 20 percent cobble and 25 percent gravel; noncalcareous; mildly alkaline (pH 7.6); gradual, smooth boundary.

B23t 63-117 cm 25-46" Brown (7.5YR 5/4) gravelly clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure that parts to strong very fine subangular blocky; hard, firm, sticky, plastic; few fine and very fine roots; few medium and common fine and very fine random tubular pores; common moderately thick clay films on ped faces and on rock fragments; 10 to 15 percent cobble and 25 to 30 percent gravel; noncalcareous, with thin lime coatings on underside of some rocks; mildly alkaline (pH 7.6); gradual, wavy boundary.

B24t 117-152cm 46-60" Yellowish red (5YR 5/6) gravelly clay loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure that parts to strong very fine subangular blocky; very hard, firm, sticky, plastic; few fine and very fine roots; few fine and common very fine random tubular pores; many moderately thick clay films on ped faces and on rock fragments; 5 percent cobble and 40 percent gravel; noncalcareous; mildly alkaline (pH 7.6).

This soil is classified as loamy-skeletal, mixed family of Typic Argiborolls. It is in the Upland Stony Loam (Pinyon-Juniper) Summer Precipitation range site.